

# **Non-Volatile Residue (NVR) Contamination from Dry Handling and Solvent Cleaning**

Marjorie F. Sovinski  
NASA/GSFC

Materials Engineering Branch, Code 541  
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# Presentation Overview

- Background
- Items Tested
- Work Instructions
- Gravimetric Determination Method
- Contact Transfer Method
- NVR Calculation Equations
- Consumables Database
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# Background

- Non-volatile Residue (NVR) consists of organic molecules/compounds
  - *Transferred to surfaces via dry handling or solvent contact*
- NVR may adversely affect
  - *Bonding strength*
  - *Cleanliness of optics*
  - *Cross Contamination via Outgassing or Contact Transfer*
- Sources of NVR generally expected to be “clean”
  - *Gloves*
  - *Wipes*
  - *Swabs*
  - *Garments*
  - *Bagging material & film*
  - *Tape*
- Situations in which NVR may be an issue
  - *Surface preparations*
  - *Clean room operations*
  - *Assembly of components*
  - *Cleaning*
  - *Project requirements/contamination allocations*
  - *Sensitive hardware near contaminated surfaces*



# Items Tested

## ■ Gloves

- Polyethylene
- Latex
- Nitrile
- Vinyl
- Polyurethane

## ■ Wipes

- Polyester
- Cotton

## ■ Swabs

- Cotton
- Poly

## ■ Miscellaneous

- Cleanroom Paper

## ■ Garments

- Coveralls
- Beard Covers
- Bouffant Caps
- Shoe Covers
- Frocks

## ■ Bagging Material

- Static Shield Bags
- Poly Bags
  - Clear
  - Pink

## ■ Film

- LDPE Film
- Anti-static Film
- Silver Film
- Pink Poly anti-static film
- Packaging Film



# Work Instructions

**Work Instructions provide a standard method for analysis of consumables**

- **541-WI-5330.1.20**
  - *Gravimetric Determination of Non-Volatile Residue in Clean Room Wipes and Swabs*
- **541-WI-5330.1.21**
  - *Gravimetric Determination and Contact Transfer of Non-volatile Residue (NVR) in Cleanroom Glove Samples*
- **541-WI-5330.1.27**
  - *Determination of Extractable Nonvolatile residue and Contact Transfer Residue from Cleanroom Garments*
- **541-WI-8072.1.7**
  - *Determination of Extractable Nonvolatile Residue (NVR) and Contact Transfer NVR from Bagging and Polymeric Films*



# Gravimetric Determination Method

## ■ Gloves & Wipes

- Extracted in 300ml solvent in an ultrasonic bath at 35°C
  - *Solvent is typically isopropyl alcohol, acetone, or hexane*
  - *Gloves are extracted for 15 minutes*
  - *Wipes are extracted for 30 minutes*
- Three trials
  - *Gloves - Each trial shall consist of two pieces of glove no less than 5cmx5cm and shall not contain any material from the fingers or cuff*
  - *Wipes - Total area of tested wipes in each trial shall be no less than 1ft<sup>2</sup>*
- Solvent is evaporated down to ~30ml in a RapidVap Evaporator using a nitrogen purge
- Remaining solvent is evaporated to dryness in clean, preweighed aluminum pans
- Residue is analyzed with Fourier Transform Infrared (FTIR) Spectroscopy

## ■ Swabs

- Extracted in 40ml solvent on a hot plate for 30 minutes
  - *Solvent is typically isopropyl alcohol, acetone, or hexane*
- Three trials
  - *Each trial includes the equivalent of 5 cotton swabs*
- Solvent is evaporated to dryness in clean, preweighed aluminum pans
- Residue is analyzed with Fourier Transform Infrared (FTIR) Spectroscopy





# Gravimetric Determination Method

- Garments & Miscellaneous Items
  - Extracted in ~30-40ml isopropyl alcohol for 30 minutes
  - Three trials, each consisting of an 8.7cm diameter piece of garment
  - Solvent is evaporated to dryness in clean, preweighed aluminum pans
  - Residue is analyzed with Fourier Transform Infrared (FTIR) Spectroscopy
  
- Bagging Material & Film
  - Interior of bag or surface of film is rinsed with ~50-70ml of isopropyl alcohol
  - Three trials
  - Solvent is evaporated to dryness in clean, preweighed aluminum pans
  - Residue is analyzed with Fourier Transform Infrared (FTIR) Spectroscopy



# Contact Transfer Method

## ■ Gloves

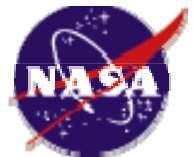
- A pre-cleaned, verified aluminum plate, 10cmx10cm minimum is inserted into a glove that has been turned inside out
- Three trials
- The inside out gloves with inserted aluminum plates are wrapped in foil and placed in a hydraulic press with 1000kg of weight for 90 minutes
- The plates are removed and rinsed with ~30ml isopropyl alcohol on both the front & back
  - *Solvent is collected in clean, preweighed aluminum pans and evaporated to dryness*
- Residue is analyzed with Fourier Transform Infrared (FTIR) Spectroscopy

## ■ Garments & Miscellaneous Items

- 6"x6" section of garment is sandwiched between two pre-cleaned pieces of aluminum foil (foil should be a minimum of 7"x7")
- A 6"x6"x1/4" stainless steel plate weighing approximately 5lb is placed on the foil/garment sample for 24 hours
- Three trials
- Rinse foil pieces which were in contact with garment sample with ~50ml of a 50/50 mixture of isopropyl alcohol and chloroform
  - *Solvent for each trial shall be collected in a clean, preweighed aluminum pan*
- Solvent is evaporated to dryness and residue is analyzed with Fourier Transform Infrared (FTIR) Spectroscopy

## ■ Bagging Material & Film

- A piece of aluminum foil large enough to fit inside the bag or to be sandwiched between the film (preferred area is 1ft<sup>2</sup>) shall be rinsed with spectroscopic grade chloroform
- Once dry, foil is placed inside bag/sandwiched between film and the bag/film is sealed
- The sample sits at room temperature for 10 days
- After 10 days, the foil is removed and rinsed with ~50-70ml isopropyl alcohol into a clean, preweighed aluminum pans and evaporated to dryness
- Residue is analyzed with Fourier Transform Infrared (FTIR) Spectroscopy
- A 24 hour test may be performed if enough bagging material is provided





# NVR Calculation Equations

$$S_f - S_i = S_t$$

Calculation of Total Sample Weight (g)

$$S_t - S_b = S_a$$

Calculation of Adjusted Sample Weight (g)

$$\frac{S_a}{A} \times \frac{10^3 \mu g}{1 mg} = NVR$$

Calculation of NVR for gloves, wipes, bags, film ( $\mu g/cm^2$ )

$$\frac{S_a}{\# Swabs} = NVR$$

Calculation of NVR for Swabs (mg/swab)

$$\frac{S_a}{\pi \left( \frac{d}{2} \right)^2} \times \frac{10^3 \mu g}{1 mg} = NVR$$

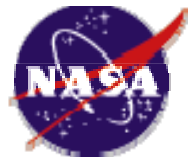
Calculation of NVR for garments ( $\mu g/cm^2$ )

A = Area (cm <sup>2</sup> )	S <sub>b</sub> = Blank Sample Weight (mg)	S <sub>t</sub> = Total Sample Weight (mg)
d= Diameter (cm)	S <sub>i</sub> = Sample Post Weight (mg)	
S <sub>a</sub> = Adjusted Sample Weight (mg)	S <sub>i</sub> = Sample Initial Weight (mg)	



# Consumables Database

- Provides a way to track lot to lot variation
- Allows a comparison of the performance of different types of consumables using the same procedure
- Provides a useful resource for projects
- A 'living' document, continuously updated with new data



# Testing for Consumables Database

## Consumable Item

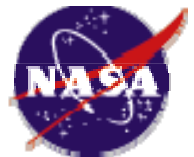
- New Item
- Old Item (different lot)

## Test for Acceptability

- Criteria determined by Codes 541 and 546 for general usage
- Add results to consumables database
- If material is purchased for general use on Center, Code 541 works to develop a fast QA inspection test that can be used as an incoming screening tool by the 549 contractor lab

## Periodic Retest

- Periodic retest of items is necessary to catch any process changes



# Recommendations

## ■ Gloves

- *Polyethylene gloves are the first choice for use when solvent exposure is a possibility*
- *Some nitrile gloves are a suitable replacement for latex gloves, and often have lower NVR levels than latex gloves*
  - *Nitrile gloves intended to be used as a replacement for latex gloves should be tested prior to lab use*
  - *Nitrile gloves with a powder coating on the interior are not acceptable*

## ■ Wipes

- *Wipes should be extracted prior to use to reduce the amount of NVR*



# Questions

